



VERIZON AIRFONE

Presentation to the
Federal Communications Commission
Regarding

WT Docket No. 03-103
“Air-to-Ground Service Rules”

September 21, 2004

Outline

- ◆ Public Interest Goals → Broadband
- ◆ Verizon Airfone Proposal → “Exclusive Use”
- ◆ Problems with Band-Sharing Proposals
- ◆ Other Issues
- ◆ Conclusions

High Demand for Broadband

- ◆ Consumers want in-flight access to the same kinds of broadband services they get on the ground.
- ◆ Airlines want broadband to improve operational efficiency.
- ◆ Law enforcement agencies want broadband for safety and national security purposes.
- ◆ Broadband service must be high-quality and available from takeoff to landing (“deck to deck” service).
- ◆ Satellite operators (Boeing, Inmarsat, ARINC) already offer or are planning to offer broadband services, and ATG rules must be changed to allow terrestrial alternatives.

Verizon Airfone Proposal

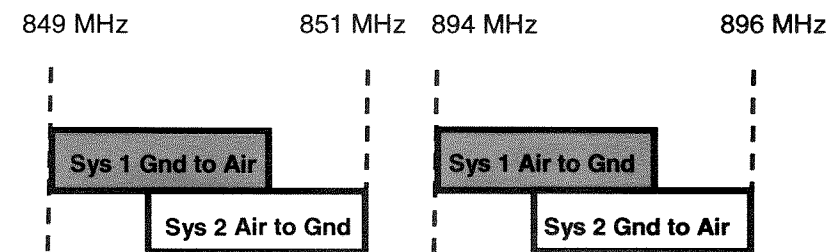
- ◆ “Exclusive use” licenses are only way to promote Broadband ATG.
 - Flexibility to innovate and respond to market forces
 - Protection from interference that impedes delivery of high-quality advanced services to consumers
- ◆ Airfone proposes licensing of “exclusive use” blocks.
- ◆ Plan supports rapid deployment of Broadband ATG using “off-the-shelf” technology.

AirCell & Boeing Proposals

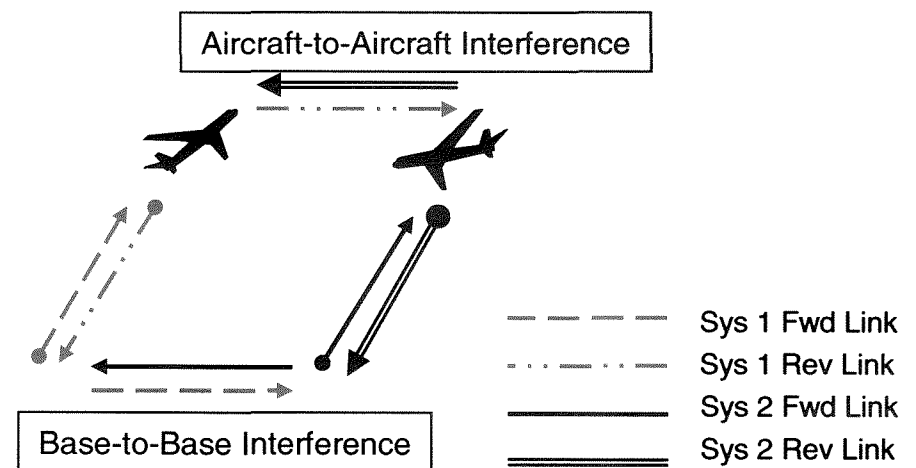
- ◆ AirCell and Boeing propose band-sharing arrangements that would have up to four licensees share the ATG band.
 - “Reverse banding” and “cross polarization” (AirCell)
 - Specialized antenna requirements (Both)
 - Strict aircraft power limits (Both)
 - Base station separations (Both)
- ◆ Each relies on equipment that is not available today.
- ◆ Each relies on inflexible and highly prescriptive rules that would restrict technology choices and service evolution.
- ◆ Neither would allow delivery of Broadband ATG.

Reverse Banding (Cross Duplex)

- ◆ Air-to-ground and ground-to-air assignments are reversed for two competing networks.



- ◆ Results in significant potential for interference between base stations and between aircraft.



Reverse Banding (Cross Duplex)

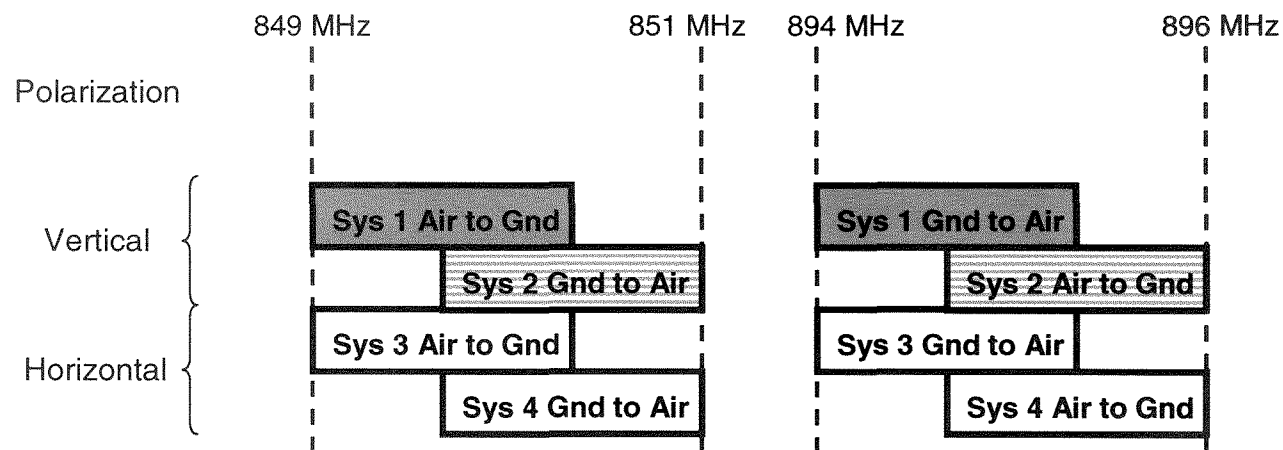
- ◆ Reverse banding is not an effective solution.
- ◆ Under real-world conditions, it would result in substantial interference to competing ATG systems.
- ◆ To minimize interference potential, AirCell proposes strict rules and requirements based on unrealistic conditions.
- ◆ Even under these unrealistically optimistic conditions, a licensee operating in cross-duplex mode would be subject to substantial interference from Navy radar and would not be able to deploy Broadband ATG.

Navy Radar Interference

- ◆ Current ATG band plan was specifically designed to avoid interference from Navy radar.
- ◆ In 2004, coastal base stations near San Diego, CA, Charlotte, NC, and St. Simons Island, GA received severe interference, resulting in service outages.
- ◆ Interference would be more severe for cross duplex, since interference would be to aircraft which has radio horizon of about 250 miles compared to about 30 miles for a base station.

Cross Polarization

- ◆ AirCell recommends the use of cross polarization, in addition to reverse-banding, to permit up to four systems to coexist.



Cross Polarization

- ◆ Cross Polarization is not an effective solution.
- ◆ It is difficult to ensure polarization purity in a mobile environment, and it is unclear whether the required isolation (12 dB) could be achieved.
 - Even AirCell acknowledges this. (AirCell, Jun. 22, 2004)
 - AirCell's 1997 test report doesn't support 12 dB isolation assumption.
 - Requirement to reduce power when 12 dB is not met is not feasible, since it is not practical to monitor actual polarization isolation.
- ◆ Cross polarization results in unacceptable increase in noise on reverse link (base station) when providing service near airports.
 - CDMA links are engineered for 6 dB interference margin to maintain dynamic range and system stability.
 - According to AirCell's own simulation results, its proposal would exceed this margin by up to 19 dB.
 - This would preclude service in areas around airports.

Specialized Antenna Requirements

- ◆ AirCell proposes a maximum EIRP of 200 mW at the horizon (± 2 degrees) for base stations located near airports. (AirCell, Sep. 9, 2004)
- ◆ Boeing proposes strict antenna gain roll-off requirements for aircraft and base stations. (Boeing, Aug. 27, 2004)
- ◆ Even with these requirements, there would still be significant interference that would preclude the provision of “deck-to-deck” service.
- ◆ Proposed antenna requirements are unrealistic and would be difficult to achieve in a commercial application.

Aircraft Power Limits

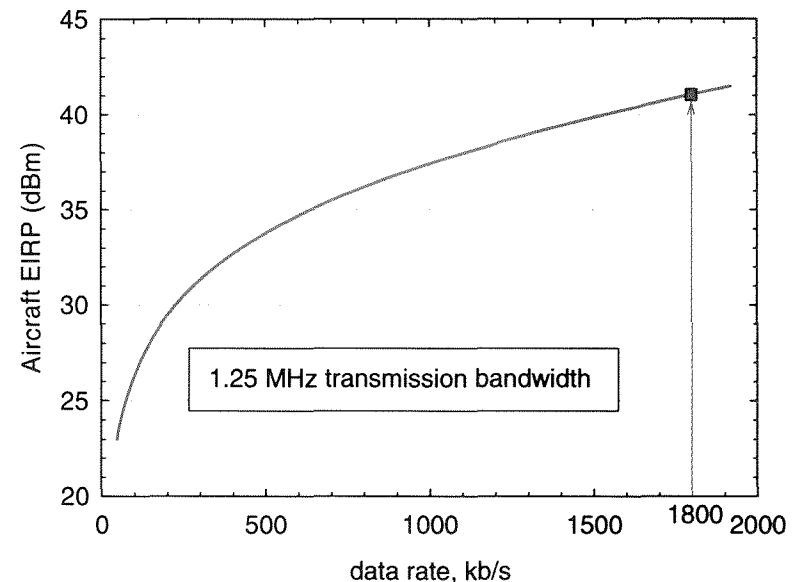
- ◆ AirCell and Boeing admit that aircraft-to-aircraft interference is a significant problem, and propose strict limits to mitigate it.
- ◆ Power Limits
 - 200 mW EIRP limit (AirCell & Boeing)
 - Reduced EIRP for polarization isolation less than 12 dB (AirCell) (not a feasible technique)
 - 14 dB additional reduction near airports (Boeing)

Aircraft Power Limits

- ◆ Strict power limits will severely limit data rates provided over ATG networks.
- ◆ As the data rate increases, the level of the signal relative to interference and noise in the system must increase.
 - Expressed as “Signal to interference plus noise ratio” (SINR)
- ◆ As a result, a high data rate system has a high SINR and a correspondingly high transmit power.
- ◆ In AirCell’s analysis, its proposed 23 dBm limit corresponds to a total reverse link rate of 48 kbps – clearly not broadband. (AirCell, Mar. 11, 2004)

Aircraft Power Limits

- ◆ Per AirCell, a 48 kbps reverse link requires 23 dBm EIRP.
- ◆ This graph shows the EIRP required vs. data rate for constant link loss.
- ◆ 1.8 Mbps would require an aircraft EIRP of 41 dBm, which would result in interference to forward link of competing system under band sharing scenario.
- ◆ With additional link losses, higher EIRP would be required.



Note: Derived from Airfone's analysis of Aug. 17, 2004.

Aircraft Power Limits

- ◆ Band sharing would severely limit the data rates delivered to the customer.

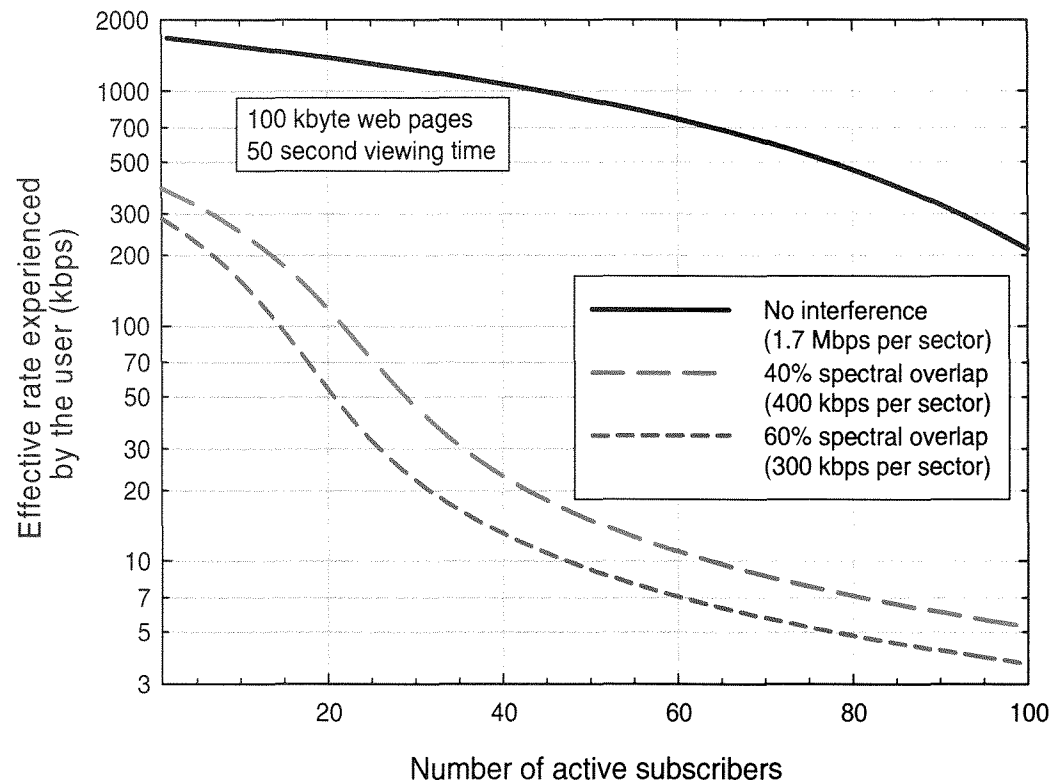
	3 Aircraft Per Sector With 15 Users Per Aircraft (kbps)	10 Aircraft Per Sector With 10 Users Per Aircraft (kbps)
No Interferers	990	212
40% Spectral Overlap	18	5.2
60% Spectral Overlap	11	3.7

Source: Telcordia study, Sep. 21, 2004. Analysis is a modification of Sep. 10, 2004 analysis and is based on a more detailed approach that uses modeling and simulation to account for data pipe congestion and transmission delay.

- ◆ Adoption of a band plan that results in overlapping licenses would effectively preclude the provision of Broadband ATG.

Determination of Effective Data Rates

- ◆ Effective rate experienced by user will always exceed average rate.
- ◆ If channel rate is changed, effective rate changes by a larger factor.



Source: Telcordia study, Sep. 21, 2004.

Base Station Separation

- ◆ AirCell and Boeing admit base-to-base interference is a significant problem, and propose mandatory separation of base stations to mitigate.
 - ☐ Minimum separation of 102 miles
 - ☐ Pre-determined location grid
 - ☐ Assignments made by FCC
- (Boeing, Aug. 27, 2004)

Base Station Separation

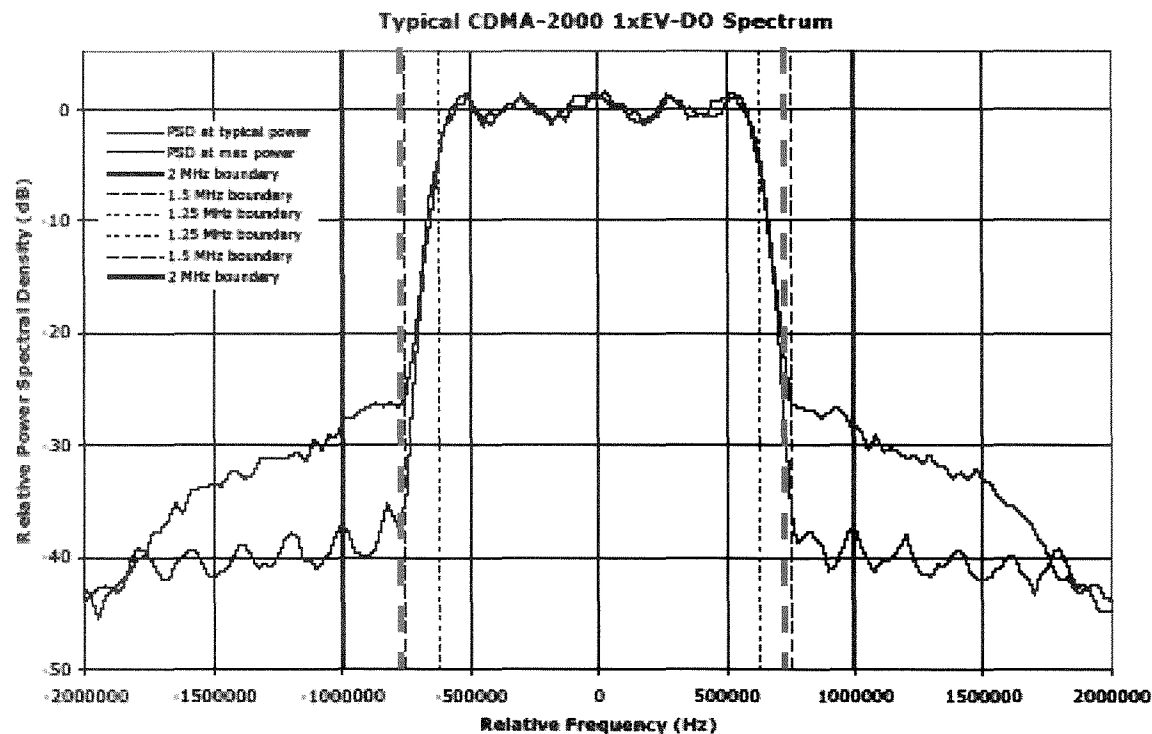
- ◆ Base station separation is not an effective solution.
- ◆ Mandatory separation limits service near airports and advantages one service provider.
- ◆ Limitations would constrain system growth.
 - Generally restricts cell-splitting
 - Higher density deployment required near airports
- ◆ Limitations would permit only one provider to serve airports and provide “deck-to-deck” services such as official airline and law enforcement communications.
- ◆ Limitations would require FCC to manage process for locating ground stations.

Importance of “Deck-to-Deck” Service

- ◆ Band-sharing proposed by AirCell and Boeing would preclude “deck to deck” service because of harmful base-to-base interference.
 - Both admit interference will limit service below 10k feet, but believe only low-speed airline communications is required
(AirCell, Sep. 9, 2004; Boeing, Sep. 10, 2004)
- ◆ Full service (voice, data, video) required from take-off to landing (“deck to deck” service).
 - Permitted today for seat-back phones on commercial flights
 - Required on commercial flights for official airline and law enforcement communications
 - Available today to private, military and governmental aircraft
(50% of Airfone customers)

Need for 3 MHz

- ◆ A 3 MHz (2 x 1.5) license block is needed to support broadband ATG technologies.
- ◆ Cannot meet -13 dBm OOB limit within 2.5 MHz.



Incumbency Rights

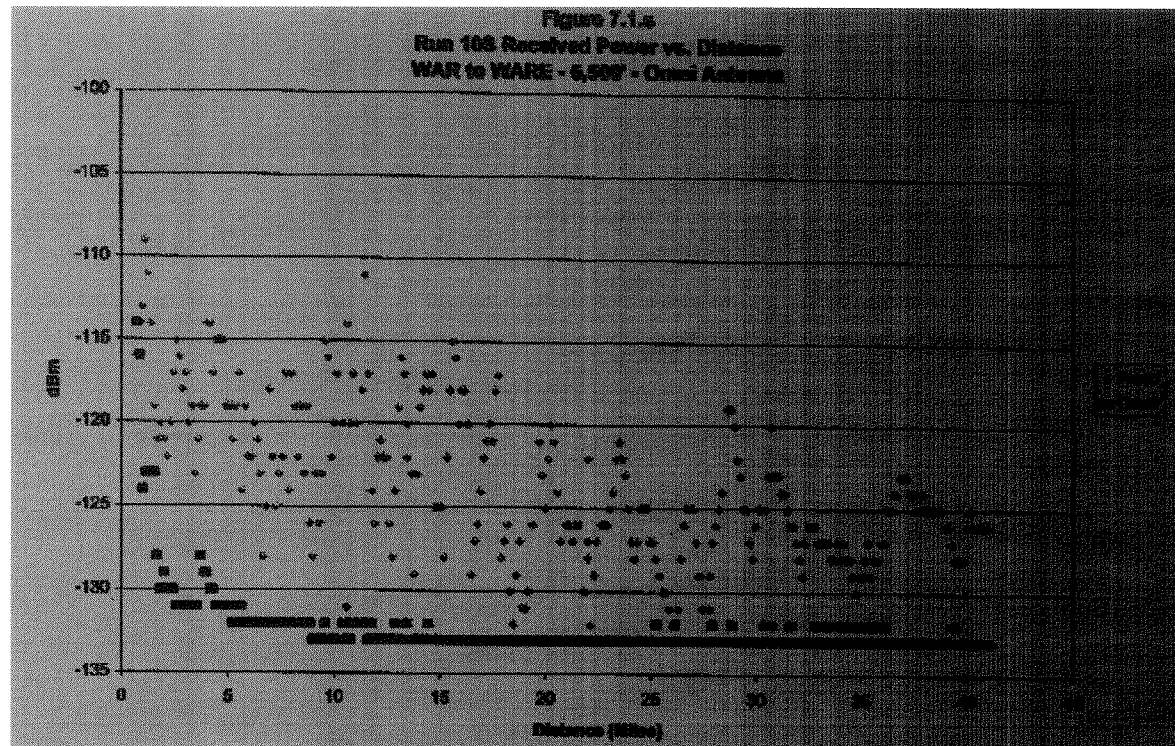
- ◆ Airfone has invested considerable time and money in pioneering the ATG service, and is the only remaining licensee in the band.
- ◆ Airfone should be allowed to continue its existing service for as long as the market supports it.
 - An arbitrary termination date is not in the public interest.
 - Airfone has a right to a reasonable renewal expectancy.
 - Revocation of Airfone's license would be inconsistent with past Commission decisions, and in any event, would require a hearing.
- ◆ If Airfone is forced to relocate, it should be compensated by the new entrant for costs to relocate to comparable spectrum.
- ◆ As the incumbent licensee, Airfone should not be precluded from bidding on any ATG license.

10 dB Implementation Margin

- ◆ Airfone's 10 dB implementation margin takes into account fading, antenna pattern variations, antenna misalignment, and a variety of equipment tolerances (cables, connectors, diplexers, and amplifiers).
- ◆ AirCell has repeatedly insisted that air-ground propagation is ideal.
- ◆ However, this is inconsistent with AirCell's own air-to-ground measurements. (AirCell Flight Tests Report, July 1997)

10 dB Implementation Margin

- ◆ AirCell's air-ground test data suggests that Airfone's 10 dB assumption for implementation margin is conservative.



Source: Final Report of the AirCell Flight Tests, July 1997

Conclusions

- ◆ There is a high demand for Broadband ATG, and FCC rules must be changed to enable terrestrial alternatives to existing satellite-based services.
- ◆ Broadband service must be high-quality and available from takeoff to landing (“deck to deck” service).
- ◆ “Exclusive use” licenses are the only way to ensure provision of high-quality Broadband ATG service.
- ◆ Band-sharing scenarios proposed by AirCell and Boeing would undermine delivery of Broadband ATG.
- ◆ Commission must protect Airfone’s incumbency rights.